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BULLETIN

OF THE

TORREY BOTANICAL CLUB

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Vol 49. No. 10

BULLETIN

OF THE

TORREY BOTANICAL CLUB

OCTOBER, 1922

The genus Costus in Central America

W. W. ROWLEE

(WITH PLATES 12–15)

As at present organized the genus *Costus* L. is composed of about one hundred species, divided almost equally between the Eastern and Western Hemispheres. Very few species occur in both hemispheres. The American species are most abundant in regions of heavy rainfall, maximum humidity and high temperature of both air and soil. The genus ranges from one Tropic to the other; it occurs wherever conditions are favorable in hot, warm and temperate regions, but is not found in high and cold districts.

In any given locality the species do not usually appear abundant, but are scattered about in deep woodlands and undisturbed jungle. The plants are herbaceous perennials with spirally arranged leaves. The stems or culms are simple and represent branches arising from a system of underground rootstocks. They thus form gregarious clusters, some of the culms remaining sterile and others producing spikes of flowers. In some cases the mats are more extensive than in others, this depending partly upon age and partly upon the habit of the plant. The leaves are ovate to lanceolate in outline and invariably entire.

In Spanish American countries members of the genus are called "canagria" or "cana agria," meaning "bitter cane,"

[The BULLETIN for September (**49**: 259–282. *pl. 10, 11*) was issued September 22, 1922.]

all jointed and unbranched stems being known as "cana" and the tissues in the present instance being very bitter. The plants are fleshy throughout their whole body structure, and their tissues are saturated with water, so that it is difficult to make satisfactory herbarium specimens. Certain parts of the plant and especially the spikes are so saturated as they grow in the field that it is easy to wring water from them. In drying they change their form markedly, and it is therefore most desirable to make observations on specimens growing under natural conditions. The flowers in many cases are delicately colored and become fragile when pressed.

The genus *Costus*, together with two or three other genera, belongs in the subfamily Costoideae of the family Zingiberaceae, the group being very distinct in its general characteristics from the other genera of the family. Two types have been recognized in the genus: in the first the floral spike is borne upon what may be called a normal leafy culm; in the second the floral spike develops upon a modified culm. In the first type the culms are designated as "not diverse;" in the second, as "diverse."

The species heretofore recorded from the Western Continent outside of South America have all belonged to the group in which the culms are not diverse. In the present paper two Central American species with diverse culms are reported and proposed as new. They are not closely related to each other, but each is represented by allied species in South America. The paper reports in addition an undescribed species from Central America in which the culms are not diverse and discusses the previously described Central American species.

Key to the Central American species

A. Culms diverse, the spikes borne on short bracteate scapes.
  B. Bracts of spikes with foliaceous appendages (Costa Rica)..... 1. *C. bracteatus*
  BB. Bracts of spikes not appendiculate (Guatemala)..... 2. *C. sepacuitensis.*
AA. Culms not diverse, the spikes borne on ordinary leafy ones.
  B. Bracts of spikes with foliaceous appendages.
    C. Spikes ovoid, green.
      D. Plants large, 2–3 m. tall; leaves about 30 cm. long, fuscous-hirsute, especially on the sheaths (Panama). 3. *C. villosissimus.*

DD. Plants small; leaves about 16 cm. long (Mexico, Costa Rica and Panama)..... 4. *C. hirsutus.*

CC. Spikes cylindrical, red.

D. Appendages of bracts lanceolate, acuminate, upper sterile erect; leaves glabrous (Guatemala and Costa Rica)..... 5. *C. Bakeri.*

DD. Appendages of bracts broadly ovate; leaves scabrous (Costa Rica) ..... 6. *C. lima.*

BB. Bracts of spikes not appendiculate.

C. Callose lacking on back of bracts (Costa Rica)..... 7. *C. Malortieanus.*

CC. Callose present on back of bracts.

D. Spike ovoid; leaves sessile (Mexico). 8. *C. pulverulentus.*

DD. Spike fusiform (Costa Rica and Guatemala)..... 9. *C. sanguineus.*

DDD. Spike cylindrical or spherical.

E. Plants small, about 2 m. high.

F. Leaves glabrous.

G. Spike red, cylindrical (Costa Rica and Panama) 10. *C. spicatus.*

GG. Spike green, spherical (Guatemala)..... 11. *C. congestus.*

FF. Leaves hairy beneath (Costa Rica and Panama)..... 12. *C. nutans.*

EE. Plant large, much more than 2 m. high.

F. Labellum orange-red with yellow markings (Costa Rica and Guatemala)..... 13. *C. splendens.*

FF. Labellum yellow (Costa Rica)..... 14. *C. laxus.*

1. **Costus bracteatus** sp. nov.

Plant clothed with long black hairs; leafy culms up to 2 m. high, the lower leaves reduced to sheathing scales; flowering culms 40 cm. tall, the leaves reduced to sheaths except the four or five uppermost, which bear small blades and closely surround the spike. Uppermost leaves on the sterile culms large and thin, 32 cm. long, 7 cm. wide, oblanceolate, acuminate at the apex and tapering below evenly to an acute base, ferruginous, hairy on both sides, the hairs arising from a bulbous base; midrib slender; venation 3.5/23;* petioles 1 cm. long, densely ferruginous-tomentose; ligules 5–10 mm. long, tomentose; sheaths

* This fraction indicates that there are 3.5 primary and 23 secondary veins to the centimeter.

overlapping, spreading-hirsute where exposed and with long appressed needle-like hairs where included in the next lower sheath: lower leaves reduced to sheaths with oblique orifices: sheaths of the flowering culms particularly loose, the uppermost leaves forming a transition to the bracts of the spike. Spike ovate-cylindrical, 13 cm. long, 6 cm. wide, conspicuously bracteate, the bracts oblong, 2–5 cm. long, 1–8 cm. wide, puberulent on the back and along the margins, strigillose within; appendages of the bracts narrowed at the base, ovate, acuminate, rusty puberulent: bracteole on the right side of the flower, conduplicate, 2.5 cm. long, with a linear callose 4 cm. long on the back near the apex, acuminate, rusty-puberulent. Flower 3.5 cm. long; ovary 5 cm. long, three-ribbed, the ribs densely tomentose, the facies less so: calyx 1.3 cm. long, rusty-puberulent, the lobes equal, triangular, 0.3 cm. long, acute: corolla three-lobed, very thin and delicate, nearly equalling the labellum, nearly as broad as long, reddish orange in the upper part: staminodia equalling the labellum, also reddish orange at the tip; stigma spoon-shaped with a notched appendage on the back. [PLATE 12.]

COSTA RICA: in woods on the hillside about a mile south of Siquirres, *H. E. Stork* (*Rowlee & Stork 675*). Specimen preserved in the herbarium of Cornell University.

Only a single mat of the species, including one flowering culm and several leafy culms, was found, although careful search was made for additional material. The plant differs from any other species known to us and is remarkable in its peculiar vesture and delicate texture. It appears to be most closely related to K. Schumann's *Costus Dinklagei* from Cameroon, Africa. The locality where this novelty was found is interesting. The old Spanish trail from the mouth of the Matina River leads westerly along the foot of the mountains to near Siquirres. It then ascends the mountains along the south side of the gorge of the Reventazon River to the central plateau, where the cities of Cartago and San Jose are located. Our plant was found near this trail. There was also found near the same place a spur (for horse-back riding) quite unlike any known to the present generation and probably dating back to the days of the buccaneer.

2. **Costus sepacuitensis** sp. nov.

Vegetative and fruiting culms diverse: leafy culms with large elliptic leaves (resembling those of *C. maximus*), at least 30 cm. long and 9 cm. wide, softly pubescent on both sides, margin ciliate; petiole 5 cm. long; ligule 1.5 cm. long, ciliate on the

margin, pubescent on upper part, glabrescent below; venation 5/25: flowering culm at least 30 cm. long, bearing only sheaths, the latter closely embracing the culm, sparsely puberulent. Spike not much exceeding the culm in thickness and appearing like it in texture and in color (dark chestnut in dried specimens): bracts broadly ovate, 4 cm. long, and 3 cm. wide, glabrous, highly polished especially within. Flowers not seen. Fruit obovoid, pubescent, 1.5 cm. long and 0.8 cm. wide, crowned with a deeply parted calyx; calyx lobes unequal, 1.3 cm. long, separated to near the base, ovate, acute. [PLATE 13.]

GUATEMALA: near the Finca Sepacuite, Alta Verapaz, April 13, 1902, *O. F. Cook & R. F. Griggs 596*. Known only from the type specimen, which is in the U. S. National Herbarium.

This remarkable plant is related to *C. geothyrsus* K. Schum. of Ecuador and *C. erythrocoryne* K. Schum. of Peru but differs from both in the shape and size of the spike, in the calyx, and in the vesture of the plant. Other species with diverse culms occur in South America and in the Eastern Hemisphere.

3. COSTUS VILLOSISSIMUS Jacq. Fragm. 51. *pl. 80.* 1800–1810

Specimens referable to this species from Central America and the West Indies exhibit considerable variation, although agreeing in stature and in having appendiculate green bracts and ovate spikes. The hairiness varies, for example, from tawny shagginess to an almost smooth condition, while the color of the flower varies from sulphur yellow to white. In all cases, however, the margin of the labellum is tinted with pink. The most typical specimen collected by H. E. Stork and the writer is No. 401, found in June, 1918, on the west side of the Panama Canal, opposite Balboa. The flowers are large and showy, the labellum being tubular, about 7.5 cm. and ivory white except for the rose red border. The whole plant and particularly the upper leaves are clothed with long tawny hairs. This specimen was 3 m. tall. Another specimen, also in bloom but only half as tall, is No. 325a, collected in September, 1918, at Quiriga, in Guatemala. It agrees with No. 401 in having tawny hairs and in the color of its flowers.

The species, although apparently rare, is widely distributed in tropical America. The following additional specimens from Central America may be cited: near Balboa, Canal Zone, Panama, *H. Pittier 3776, 3779, 6690;* Province of Alta Verapaz, Guatemala, *O. F. Cook & R. F. Griggs 308.*

4. COSTUS HIRSUTUS C. Presl, Reliq. Haenk. 1: 112. 1830

This is a much smaller plant than the foregoing, according to the writer's interpretation, and is evidently not more than 50 cm. high. The spike also is smaller. The following specimen seems to be characteristic: on the cattle trail between the Chiriqui Lagoon and the divide, western Panama, *H. E. Stork* (*Rowlee & Stork 1045*). Another specimen to be associated with the species is the following: upper stretch of the Saraquipi River, *H. Pittier 14166*. Both represent a diminutive *C. villosissimus*. The published descriptions of *C. hirsutus* are meager, and no drawing or photograph of the species has been seen by the writer.

5. COSTUS BAKERI K. Schum.; Engler, Pflanzenreich **4**[46]: 387. 1904

The following specimens of this species, all from the uplands of central and western Guatemala, have been studied: Barranca del Samalá, Dept. Retalhulen, 1700 ft. alt., *J. Donnell Smith 2801*; Barranca de Eminencia, Dept. Amatitlan, 1400 ft. alt., *J. Donnell Smith 2802* (Type); Volcan Tecuamburro, Dept. Santa Rosa, *J. Donnell Smith 4650*. The following specimen from central Costa Rica has likewise been examined: *A. Tonduz 282*.

C. Bakeri is characterized by having a cylindrical and appendiculate spike, more or less red in color; the appendages of the bracts being acute and longer than wide. In these respects it agrees with *C. comosus* (Jacq.) Roscoe, of northern Colombia and Venezuela, a species with which it was originally confused. In *C. comosus*, however, the upper surface of the leaves is softly hairy, while in *C. Bakeri* it is perfectly glabrous. It is probable that intermediates between these two species will be found.

6. COSTUS LIMA K. Schum.; Engler, Pflanzenreich **4**[46]: 388. 1904

Dr. Schumann apparently knew *C. lima* from the type specimen only, which was collected at the following station on the Pacific side of Costa Rica: near Punta Arenas, January, 1854, *Scherzer*. The species is frequent however, throughout the lowlands in the northern part of Costa Rica, being found also on the Atlantic side. The following additional specimens may be cited: Buenos Aires, near the continental divide, *A. Tonduz 6659;* Livingston on the Reventazon River, *Rowlee & Stork 648;* Siquirres, *Rowlee & Stork 1318*.

It agrees with *C. Bakeri* in having an appendiculate, cylindrical spike, often much shortened, but the color is more brilliantly red, making the spike very conspicuous. The appendages, moreover, differ in being shorter and less striking. The species is further characterized by the peculiar vesture of the very opaque leaves, the upper surface being clothed with shorter bulbous hairs, all pointing toward the apex, while the lower surface is densely covered by a tawny tomentum. The plants are large, often 5–7 m. high, and the spike is about the size of an ear of corn.

According to the original account *C. lima* is related to *C. Friedrichsenii* O. G. Peters., a species described from plants cultivated at Berlin. Dr. Schumann states that it was probably introduced from Central America, but the writer has seen no specimen agreeing with the description.

7. COSTUS MALORTIEANUS Wendl. Hamb. Garten- u. Blumenzeit. **19**: 30. 1863

So far as the writer's observations go *C. Malortieanus* is confined to the coastal plains of northeastern Costa Rica. The type locality is near the Sarapiqui River at the head of navigation, and the original description was drawn from specimens cultivated in Germany. The species grows also along the Reventazon River, where it emerges on to the lowlands. It is the gem of the genus. The plants are small, being less than 1 m. high, and grow in wide spreading mats, flowering in July and August. The flowers, which are not freely produced, are very beautiful, suggesting in their tints some of the tropical orchids. The leaves are broadly obovate, densely hairy, and obscurely variegated with darker and lighter threads of green. Specimens in the greenhouses of the New York Botanical Garden, although under cultivation for several years, have not as yet produced flowers.

Two other species of tropical North America with unappendaged bracts and no callose have been described under the names *C. pictus* D. Don, and *C. mexicanus* Liebm. Specimens of the first two have not been found by the writer, but both are apparently of Mexican origin, *C. pictus* being based on plants grown in England.

8. COSTUS PULVERULENTUS C. Presl, Reliq. Haenk. 1:41. 1830

The original specimen of *C. pulverulenus* was collected in Mexico by Haenke, no more definite locality being mentioned. The writer has identified with it, somewhat doubtfully, the following specimen from Guatemala, origina'ly referred to *C. Malortieanus*: Rio Sis, Dept. Suchitepequez, 1300 ft. alt., *J. Donnell Smith 4800*. This and the following six species agree in having a callose on the back of the bracts.

9. COSTUS SANGUINEUS Donn. Sm. Bot. Gaz. **31**: 122. 1901

This species is the most frequent representative of the genus in northern Costa Rica, and a photograph of it has been reproduced in Calvert's "A year of Costa Rican Natural History," opposite page 257, under the incorrect name *C. Malortieanus*. It is not found on the beach but inhabits higher ground, often at an elevation of as much as 2000 feet. The type specimen was collected in 1901, at Cubilquitz, Dept. Alta Verapaz, Guatemala, about 1000 ft. alt., by H. von Tuerckheim (No. 7686), but the species has been found in other Central American countries bounding the Carribbean Sea. The following specimens may be cited: Peralta, *Rowlee & Stork 45;* Livingston on the Reventazon River, *Rowlee & Stork 653;* and Siquirres, *Rowlee & Stork 1311, 1312*. The plant is about 1.5 m. high, and the leaves are softly pubescent. The red spikes are fusiform and acute, when perfectly developed, as shown in Calvert's figure, but they are frequently deformed and much shortened.

10. COSTUS SPICATUS (Jacq.) Sw. Prodr. Fl. Ind. Occ. 11. 1788

The original material of *C. spicatus* came from the West Indies, where the species is widely distributed. It is found, also, in the close vicinity of the seashore in northern Costa Rica, between Limon and the mouth of the Matina River. The following specimens may be referred to it: Chargres, 1850. *A. Fendler 446*; Rio Dulce, March, 1889, *J. Donnell Smith;* vicinity of Frio, province of Colon, August, 1911, *H. Pittier 4137;* Limon, *Rowlee & Stork 674*. The field notes that follow were made from No. 674.

Culms 1–2 m. high, many from a rather dense mat, leafy to near the base, whole plant glabrous. Leaves 18 cm. long, 7 cm. wide, elliptic, short-acuminate

at the apex, subauriculate at the base, shining green above, glacuous beneath, petioles 6 mm. long, sheath shorter than the internodes, ligule 5 mm. long, three or four leaves approximate to the base of the spike, venation 7735. Spike oblong, 7 cm. long, 2.3 cm. thick, very compact. Bracts nearly orbicular, 2.5–3 cm. in diameter. Bracteole 1.5 cm. long, relatively broad, boat-shaped, dextrad. Ovary 5 cm. long, glabrous, subtrigonous, seeds very numerous, angular with elater-like aril. Calyx 5 cm. long, campanulate and with very short broad lobes and red margins. Corolla orange-red, 2 cm. long, dilated at the apex, lobed to the middle, lobes oblong, acute. Labellum 3 cm. long, obovate, subtrilobed, yellow. Stamen 2.5 cm. long, lanceolate, obtuse, anther adnate above the middle.

11. **Costus congestus** sp. nov.

Stem less than 1 m. high. Leaves crowded near the summit; petioles 5 cm. long; blade 24 cm. long, 6 cm. wide, acuminate at the apex, tapering from above the middle toward the base, slightly glaucous beneath, green above, glabrous throughout. Spike spherical, about 4 cm. in length and breadth; lower bracts with leafy appendages; bract proper orbicular, red, with a callose line. Ovary glabrous, 4 mm. long; calyx divided to the base, the lobes unequal, oblong, rounded, at the apex; petals large, hyaline, obtuse; labellum 4 cm. long. [PLATE 14.]

GUATEMALA: Escuintla, 1100 ft. alt., March, 1890, *J. Donnell Smith 2036* (Type); Santa Lucia, Dept. Escuintla, 1045 ft. alt., March 3, 1905, *W. A. Kellerman 5284*; Santa Barbara, Dept. Solola, 1370 ft. alt., August, 1891, *J. Donnell Smith 137*. Type specimen in the herbarium of Cornell University.

MEXICO: vicinity of Choapam, Oaxaca, 3800–4500 ft. alt., July 28, 1894, *E. W. Nelson 911*.

The species is glabrous in all its parts. It differs from *C. spicatus* (Jacq.) Sw., to which Baker referred some of the specimens, in the size of the flower and in the shape and size of the spike.

12. COSTUS NUTANS K. Schum.; Engler, Pflanzenreich 4^{46}: 407. 1904

The type material of *C. nutans* came from the following locality: near Aguacate, Costa Rica, September, 1857 (in flower), *C. Hoffman 727*.

The only specimen seen by the writer was collected on Mount Pirri, Panama, on June 12, 1912, by E. A. Goldman (No. 1963) at an altitude of 1350 m. [PLATE 15.]

13. COSTUS SPLENDENS Donn. Sm. & Tuerckheim; Donnell Smith, Bot. Gaz. **33**: 260. 1902

Costus maximus K. Schum.; Engler, Pflanzenreich **4**[46]: 405. 1904. *Costus giganteus* Kuntze, Rev. Gen. **2**: 687. 1891. Not Ridley, 1887.

The species was based on a specimen collected in Guatemala at an altitude of 350 m., by H. von Tuerckheim (No. 8015), no more definite locality being mentioned. The writer has not seen the type specimen, but other material collected in Guatemala by Von Tuerckheim and referred to *C. splendens* has been available for study. In this material the bracts bear a callose below the apex, although no structure of this sort is mentioned in the original description. Since these specimens are indistinguishable from *C. maximus* K. Schum., the name *C. splendens* will have to supplant the later name *C. maximus*, and the known range of the species will extend from Guatemala to Panama.

14. COSTUS LAXUS O. G. Peters.; Martius, Fl. Brasil. **3**[3]: 56. 1890

The type specimen was collected in Costa Rica by Aented in 1847, the name of the locality being illegible. The species is known also from Venezuela.

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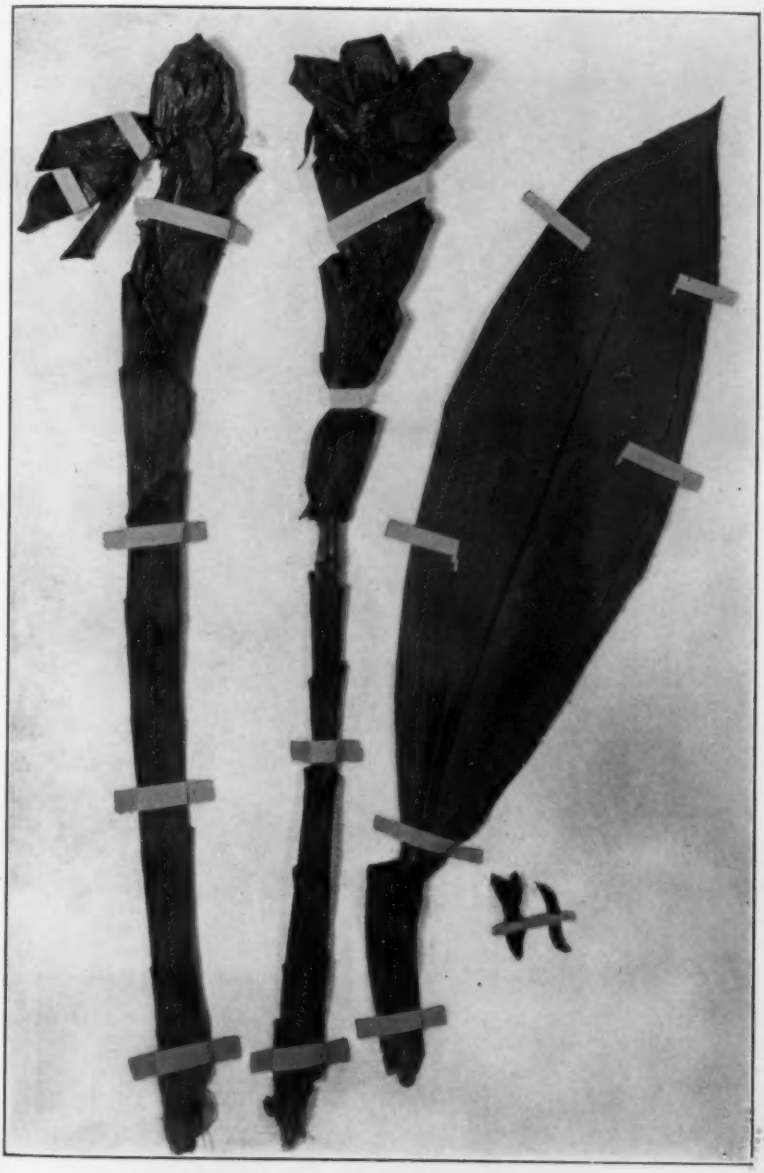
Explanation of plates 12-15

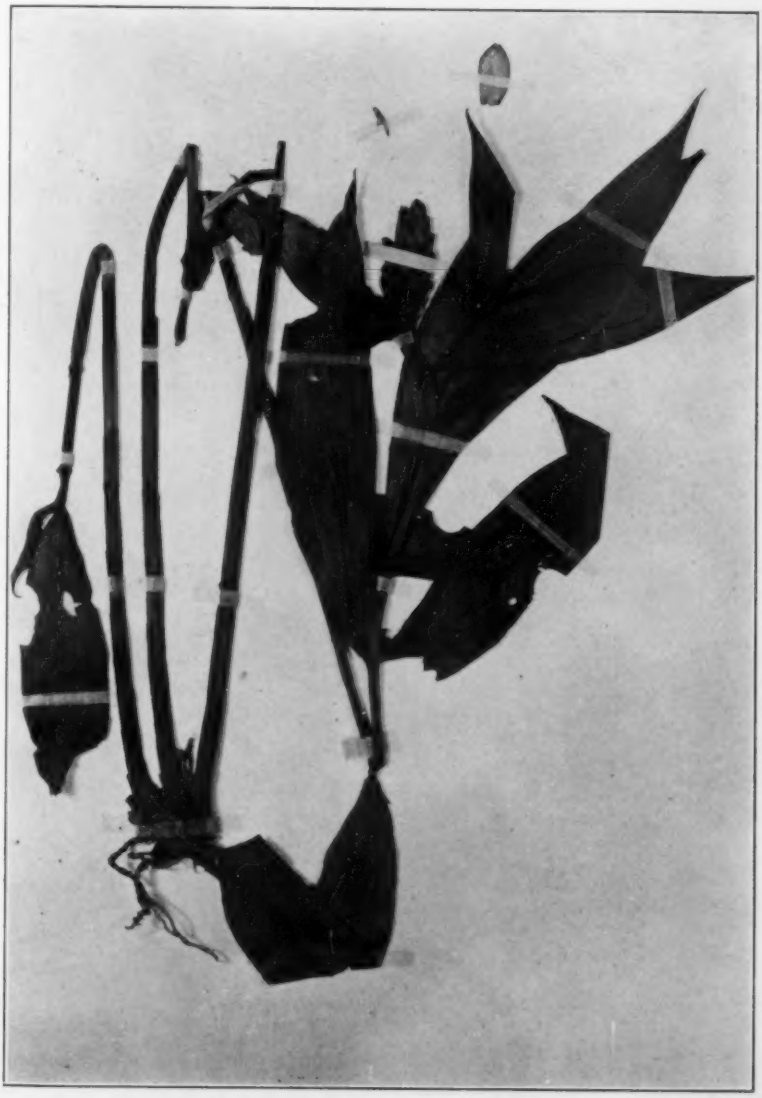
PLATE 12. COSTUS BRACTEATUS Rowlee.
PLATE 13. COSTUS SEPACUITENSIS Rowlee.
PLATE 14. COSTUS CONGESTUS Rowlee.
PLATE 15. COSTUS NUTANS K. Schum.

COSTUS BRACTEATUS ROWLEE



COSTUS SEPACUITENSIS ROWLEE

COSTUS CONGESTUS ROWLEE



COSTUS NUTANS K. SCHUM.

Quercus lyrata in Iowa

B. SHIMEK

(WITH PLATES 16 AND 17)

The discovery of the overcup oak, *Quercus lyrata* Walter, in Iowa, by the writer, so far extends the range of this species that it seems worthy of more detailed record. Sargent says* that the species "is distributed from the valley of the Patunxent River in southern Maryland southward near the coast to western Florida, through the Gulf States to the valley of the Trinity River in Texas, through Arkansas and southwestern Missouri, where in a swamp near Allentown, there is a single specimen, the most northern known representative of the species west of the Mississippi River, to central Tennessee, southern Indiana, and Jasper County, Illinois."

Other authors give the distribution less fully, but in all the references consulted the range falls within that here given. The herbarium of the Missouri Botanical Garden at St. Louis contains several specimens from the southern counties of Illinois, and from Butler County, Missouri, but these localities also lie within the territory given by Sargent.

The Iowa specimens are located in Iowa County, near the town of Amana. This not only extends the northern range west of the Mississippi, but the locality is more than two degrees of latitude north of the Maryland and Illinois localities, making this the northernmost point from which the species is known.

Thus far three trees have been found. They are located in the low bottom land timber along the Iowa River, the locality being subject to overflow and always quite moist. They are associated with the large, bottomland form of the bur oak, *Quercus macrocarpa*, a few trees of *Q. bicolor*, and the ordinary bottomland species of Iowa valleys, such as *Ulmus americana*, *Betula nigra*, *Populus deltoides*, *Acer saccharinum*, *A. Negundo*, *Platanus occidentalis*, and *Juglans nigra*. Other trees of the species will probably be found among the "bur-oaks."

The finest of the three specimens (shown in PLATE 16, FIG. 1) is about 70 feet high, and the trunk measures 22 inches in diameter at a height of 3 feet. Its rate of growth is probably approxi-

*Silva of North America **8**: 48. 1895.

mately the same as that of the large bottomland form of *Q. macrocarpa*, and a nearby specimen of the latter, recently cut, measured 27 inches in diameter and exhibited about 120 rings, those from about 55 to 85 showing the most rapid growth. Our overcup oak trees are probably not less than a hundred years old, thus antedating the coming of the white man to this section.

The trees have been observed both in flower and fruit. Sargent gives the time of flowering as March or April, but in this northern locality the flowers do not appear until about the middle of May.

Two of the trees produce acorns which are entirely enclosed in the cup; the third has a partly open cup, a form not infrequent in the South. The peduncles of the cups are 6–16 mm. in length. The wall of the cup is 3–6 mm. thick or even thicker at the base, but thins upward. The scales of the cup are prominently tubercular, the tubercles becoming smaller upward. The small opening has a short fringe.

The nut is short-ovate, with a broad basal scar and is 16–19 mm. in length, with about the same diameter. Its tops and sides are covered with a short, grayish pubescence. For cup and acorns see PLATE 16, FIG. 2.

The general aspect of the tree is not unlike that of the large form of *Q. macrocarpa* which grows in somewhat better drained spots in the same timber. The latter is here not gnarled or stunted, as is usually the case in more exposed localities. It is probable that our species has been mistaken for the latter in other localities.

The leaves are distinctly different from those of the nearby bur-oaks. As compared with the latter they are thinner, with more distinct veinlets; lighter green; more irregularly lobed, with the terminal lobe rarely coarsely crenate; usually smaller and narrower; and the upper surface is more likely to have scattered short hairs at maturity, while the pubescence of the lower surface is much less dense. PLATE 16, FIG. 3, shows young leaves, and PLATE 17 shows mature leaves taken in different years. The leaves and acorns shown on the plates are from the same tree.

On the whole the Iowa specimens of *Q. lyrata* are quite typical.

Explanation of plates 16 and 17

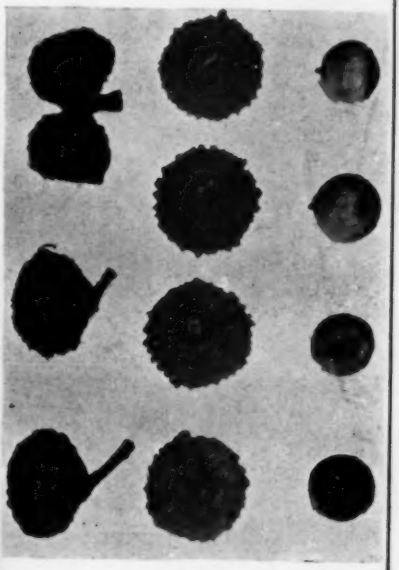
PLATE 16

FIG. 1. *Quercus lyrata* Walt., a leafless tree.
FIG. 2. Cups and acorns, x .55.
FIG. 3. Young leaves and flowering twig, x .42.

PLATE 17

FIG. 1. Mature leaves of *Quercus lyrata*, x .24.
FIG. 2. Old leaves, taken a year earlier, x .30.

1



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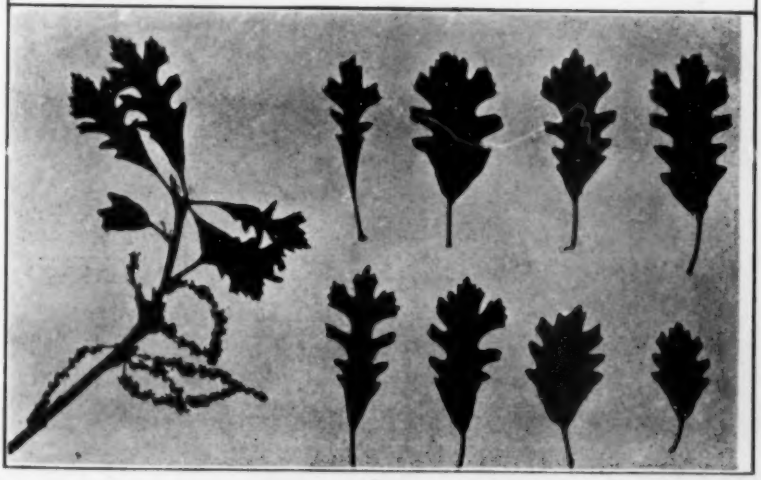

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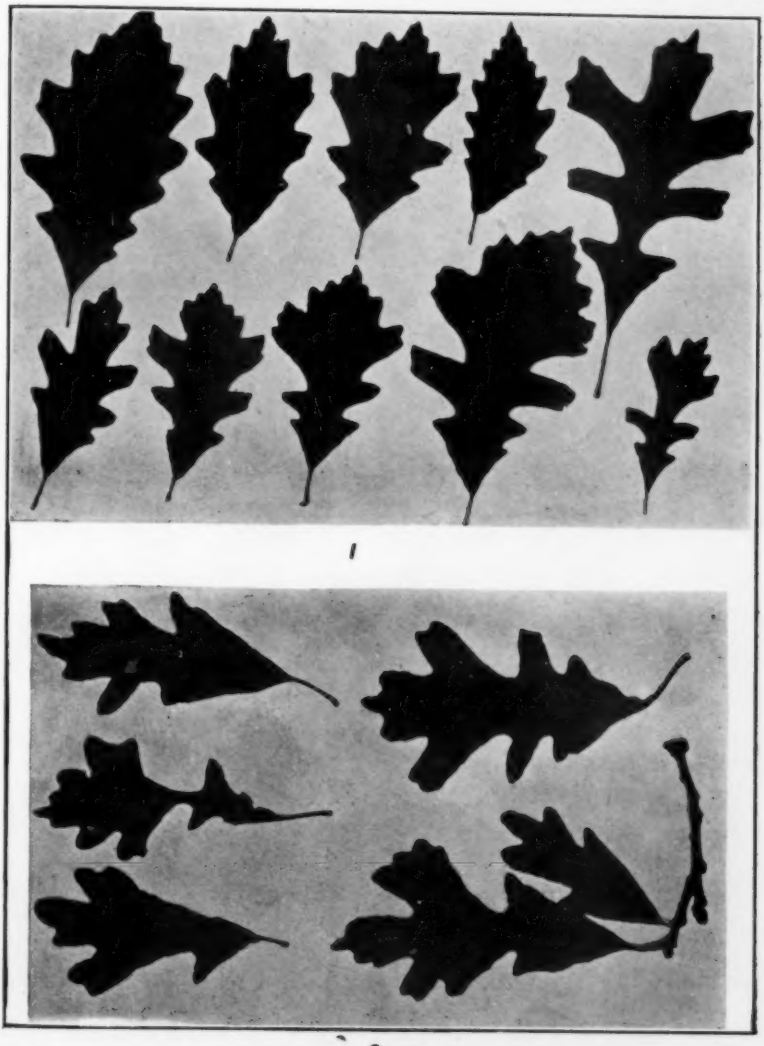
QUERCUS LYRATA WALTER



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QUERCUS LYRATA WALTER

References to the algae in the Chinese classics

W. M. Porterfield, Jr.

(with one text figure)

The following notes on the algae referred to in ancient Chinese literature are at best sketchy, but are offered nevertheless for what they are worth. The references to the texts and the translations thereof are quoted on the authority of Mr. Y. T. Chu, Instructor of Biology at St. John's University, Shanghai, China, and Mr. C. F. Wu, formerly of St. John's, now of Cornell. The writer presents this paper with a view to throwing some new light on the development of science in general, and to introducing to the West, besides, some evidences of Far Eastern activity in this line, which parallels, if not predates, that of Europe.

Agriculture in China dates back to Shen Nung,* an emperor of the legendary period, 3000 B. C. He was said to be the first farmer and taught the people to till their fields. Since this mythical age, the people of China have been farmers primarily. As the Old Testament was essentially the expression of an agricultural and pastoral people and is, in consequence, replete with similes and references to plants and animals, so in the Chinese classics we find the farming life of the people, a life of continuous touch with nature, coming to expression in the frequently recurring allusions to animals and plants, and in the use of terms connected therewith. Long before the Aristotelian age of hearsay and philosophical conjecture, the ordinary facts of farming and floriculture had entered the realms of Chinese literature in the form of terms serving as figurative expressions for desirable characters and virtues. In order to have given time for everyone to become so familiar with these original terms that they crept unconsciously into speech and literature as specific classifiers, observation of the form and structure of plants must already have proceeded far. This is offered as one evidence of age-old familiarity with the facts of nature. The second is coincident with the first and deals with the ideographs representing these terms and ideas. The discovery and use of the facts of nature called into being special ideographs to

*Appendix, "Peking," by Juliet Bredon.

represent them, so that owing to the character of the language and its slow evolution, we feel that the appearance of these specific terms in the ancient literature places the knowledge back of them at a very early date.

We shall confine ourselves to the algae in this paper. The Chinese character, as we are accustomed to term the ideograph, is built up of many radicals or elementary symbols supposed formerly to have been pictures which taken together represent an idea. The character for algae is Tsao (FIG. 1) and may be resolved into four radicals, the ones for grass, water, wood, and mouth, the latter being repeated three times. The mouth radical is a simple rectangle, which when repeated three times and placed in the form of a pyramid, two at the bottom and one on top, make up an ideograph which means rank or character. This latter smaller ideograph seems to carry with its meaning the idea of segmented, or possibly cellular (!) structure because of the shape of the thrice repeated box-shaped radicals. Evidently the idea in their minds from the character used was that of a grass-like, fibrous or stringy, cellular plant that grows in the water. Such an analysis leads us to believe that they had in general a good idea of what an alga is.

FIG. 1. TSAO

a, grass radical; *b*, mouth radical; *c*, wood radical; *e*, water radical; *f*, small ideograph meaning rank or segment.

The character for Tsao first appeared in one of the five classics, the Canon of Boems (FIG. 1). In the chapter Chao Nan there appears the following passage, the romanized version of which is here given: "'yü bih bien tsao" (with respect to the collecting of algae). This term is still used today. The term for water plants is a much simpler character and therefore is much more general in its meaning. It has the grass and water radicals but no specifically descriptive ones. There can be no confusion then in the use of these terms.

In support of the cellular or segmented idea of algae brought out in the analysis of the character, K'ung An-kuo, in the Canon of History, says that "an alga is an aquatic plant that has systematically arranged branching parts, and is used, therefore, (figuratively) to denote literature." He may here be referring

to the diagrammatic structure of *Hydrodictyon*. Nearly two thousand years ago in a pond beside the temple of Han Voo Tee, algae were said to have grown to a length of nine feet. Among other characteristics they were reported as having the appearance of a net from which certain water birds were said to have had great difficulty in extricating themselves. The people called this the water-net alga. The structure of such types was plainly visible under careful scrutiny, hence a netted or reticulate structure was specifically attributed to algae.

About 600 B. C., in a book entitled Sze tsen, occurs the following reference to algae: "Some algae are a delicacy fit for the most honorable guest, even for the king himself." At the present time country people gather *Nostoc* for food. This is called "Heaven vegetable." Red algae are dried and eaten by farmers who live near the sea. It is to some of these doubtless that the quotation refers.

The real knowledge in Chinese medicine as it exists today is based on the Chinese "Materia Medica," the edition of which was begun four thousand years ago. The present edition was written two hundred years ago in the Ming dynasty. Among other plants, Kw'un Boo, or *Laminaria* is mentioned as being useful for medicinal purposes, for which it is calcined after being washed and sun-dried. It is a common practice in China to pack open cuts with ashes in order to stop the bleeding. Whether there is any discrimination shown as to what kinds of ashes are used the writer is not prepared to say. If there is, it is interesting to note that in case preference was shown for ashes of kelps, they must have realized that some medicinal virtue was contained in them. Iodine as an element was probably not known to the Chinese but they may have realized its presence as a virtuous remedy in other things.

As in western countries the sea weeds of the China coast are used by the farmers nearby for fertilizer and also, when dried for fuel. Agar-agar is made by the Chinese out of certain species of sea-weeds, a well known fact to most scientists and technicians.

The morphological characters of these marine forms seem to have been as well known as the freshwater forms, if not better. Many were said to be attached to stones. The large leafed forms were known as ox or horse algae. Some float on the top of the water, others live at the bottom. Of the smaller forms,

many have long silk-like filaments, the longer ones more than thirty "segments" each, and others have the appearance of "uncombed hair."

Metaphorically the term for algae is used in a very complimentary sense. The elegance and beauty of essays was often designated by or compared to that of the algae. The term was used in praise of the thinking of a learned man, signifying that his thoughts were as systematically ordered as the parts of an alga. Judgment was in like manner complimented. The algae contributed not only to the language and literature of the Chinese but also to their art and superstitions. In an old book called Zong Shu, we find reference to conventionalized designs derived from algae being included in the embroidery of their garments. When the figures of algae appeared on the ends of the roof beams of their houses in brilliant colors, we find that the underlying idea was protection from fire. Because algae were known to be water plants, any evidence of them on houses was a protection against fire in that the former invoked the aid of their native element to drive away the fire spirit.

From this discussion we begin to realize that from direct references in ancient Chinese literature and an analysis of the ideograph, there is a possibility, if not a probability, that the knowledge of the algae as a distinct morphologic unit in the plant kingdom dates back to very early times, as compared with the state of knowledge in western countries. Moreover this knowledge seemed to be more wide spread amongst the people from the use of Tsao in a metaphorical sense, in its practical use as medicine, as food and fuel, and as fertilizer; as the basis of commercial products; and in the realization of its decorative value and its superstitious meaning.

A Lachnea with a botryose conidial stage

B. O. Dodge

(WITH SEVEN TEXT FIGURES)

While engaged in culturing species of Discomycetes for the purpose of studying the nature of the origin of the ascocarp, an interesting *Lachnea* was collected several different times in 1912 on a variety of substrata in the vicinity of New York City. The apothecium of this fungus, which was identified* at the time as *Lachnea abundans* Karst., originates in a long winding multicellular ascogonium, so similar to that described by Fraser† for *L. cretea* that, when we consider also the characters of the fruit bodies and mycelium, there appears to be little doubt that the fungi with which both of us were working are at least very closely related species. Believing that the characteristics of the primordia are of fundamental importance in determining relationships, further discussion, other than the mention made in a paper published at that time,‡ seemed unnecessary.

Miss Fraser does not state that she grew *L. cretea* in pure cultures. Her cultures were originally derived presumably by transfers from a plate culture overrun with moulds and some hyphomycetous fungus. It would be necessary to know whether *L. cretea* has a conidial stage like that which we have connected with *L. abundans* before we can be certain that the species are identical. In view of the discussions that have arisen since the publication by Seaver and Horne* of a paper on *Sclerotinia Geranii* and another paper by Godfrey† on *Sclerotinia Ricini*, both of these forms having *Botrytis* conidial stages, it has been thought advisable to point out that there are other types of Discomycetes which also have asexual fructifications closely resembling *Botrytis*.

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* The identification has been confirmed by Dr. F. J. Seaver, who is considering *L. cretea* as a possible synonym.

† Ann. Bot. **27**: 553–563. 1913.

‡ Bull. Torrey Club **41**: 165 1914.

* Mem. Torrey Club **17**: 202–206. 1917.

† Phytopathology **9**: 565–567. 1919.

The conidia of *Lachnea abundans* are smooth at maturity while those of *Sclerotinia Geranii* are rough or warted, otherwise their conidial stages are very similar. The connection between the apothecial and the conidial stage of *L. abundans* has been established repeatedly by cultures from single conidia and from single ascospores, apothecia arising in each case within a week or two after showing the spores.

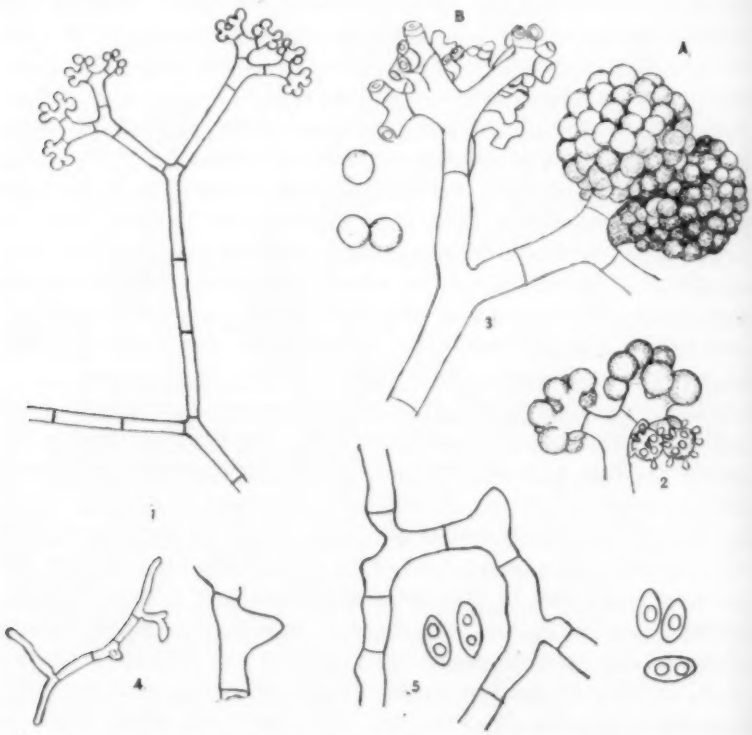


FIG. 1. Part of a dichotomously branched conidiophore showing the enlarged ends of the ultimate branchlets upon which spores will be borne.

FIG. 2. End branches of a similar stage more highly magnified, spore buds arising from two of the globular heads.

FIG. 3. Portion of an old conidiophore showing botryose clusters of spores, A, developed on about sixteen fertile ends; B, shows the collapsed ends of the conidiophore after the spores have been dislodged.

FIGS. 4 and 5. Germinated ascospore becomes a cell in the hypha; FIG. 5 also shows ungerminated ascospores.

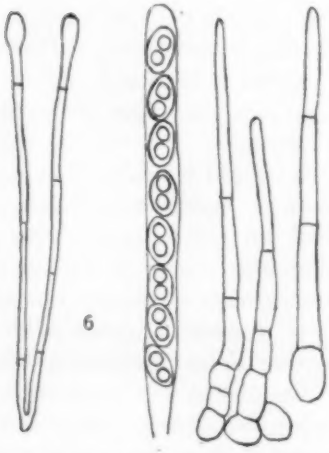
Ascospores germinate very readily when the inoculated culture

medium is heated to 70° C. for about fifteen minutes. This method has been found effectual in inducing germination of ascospores of certain other species of Discomycetes.‡ The outlines of the spore are generally obscured as it germinates and becomes a cell in the hypha (FIGS. 4, 5,). The conidia as well as the ascospores remain viable for a long time if kept dry in the laboratory, the former, sometimes living three or four years. Should several conidia be sowed together in a culture there follows at once a great amount of anastomosing of the germ tubes.

The fungus grows well on almost any of the ordinary culture media. Conidiophores arise the second day in cultures on milk, bouillon, potato agar, etc. An agar medium in which the nutrient is a decoction from heated soil is especially favorable for the development of ascocarps. A potato dextrose agar gives an abnormal amount of conidial development. The conidia are formed on the spherical or knob-shaped ends of regularly dichotomously branched conidiophores, seven or eight such divisions often occurring. One might consider an aerial hypha whose main axis ends in a pair of sporophores as a part of the conidiophore system even though branches ultimately bearing conidia arise at irregular intervals from it. FIG. 1 shows a branch of the third order at the time spore formation is just beginning. A portion of such a branch is further enlarged in FIG. 2, showing conidial buds from two of the ultimate branchlets. As spores mature they hang together in botryose clusters covering about eight pairs of end branches (FIG. 3, A). At B in this figure the conidia have been dislodged, exposing the extremities of the conidiophore subdivisions, now collapsed. The length of the conidiophore system and the number of times dichotomous branching occurs depend of course upon the kind of nutrient in the medium. On soil decoction agar the sporophores are very short, and there is very little of the aerial type of hyphae. The mycelial hyphae on the other hand branch more or less dichotomously and in this respect also the fungus is like the *L. cretea* studied by Fraser. The color of the aerial hyphae, conidiophores and conidia in mass varies from pale ochraceous buff to vinaceous buff (Ridgway), depending on age and vigor of growth.

‡ Mycologia **4**: 218–222. 1912.

The conidia are spherical, smooth, faintly colored, pale ochraceous buff in mass, 7–9 μ in diameter. The ascogonia begin to appear, as noted, in about ten days, and mature fruit bodies will be formed within two or three weeks. Fraser lays considerable stress on the branching of the trichogyne end of the ascogonium of *L. cretea*, thinking such vegetative growth the "progressive degeneration" of Atkinson, indicates that the species is becoming apogamous. Many such abnormal or aborted ascogonia are always found in cultures of these Discomycetes and they should be carefully distinguished from those



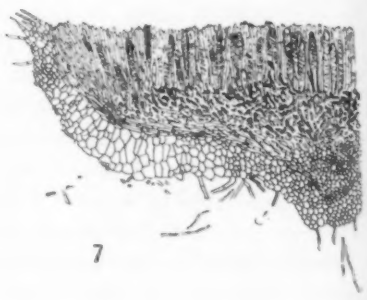


FIG. 6. Hairs from the margin of the apothecium, ascus with spores and paraphyses.

FIG. 7. Part of a section of a small apothecium showing the character of the cells of the wall and of the margin.

normal primoridia which develop into fruit bodies. Ascocarps of *L. abundans* (FIG. 7) are 1–3 mm. in diameter and uniformly ochraceous in color. The hairs (FIG. 6) are about 150 μ long, the asci 130–150 μ, and the ascospores 7–8 x 12–14 μ. The paraphyses, which are enlarged rather abruptly at the ends, are 4–5 μ broad.

It is certainly dangerous to place too much weight on the asexual spore forms in determining relationships of their ascogenous stages in the face of these apparently anomalous cases and such others as we find in *Ascobolus magnificus*, which is connected

with a *Papulospora** similar to those forms hitherto thought to belong to *Melanospora*. If one, following Saccardo, for example, seeks to find a description which might apply to the conidial stage of *Sclerotinia Geranii* or of *Lachnea abundans* he turns directly to the forms along with *Botrytis cinerea* on the basis of the spore clusters. It seems to the writer, therefore, an impossible task to determine the real generic affinities of species of form genera from a study of the conidial or pycnidial stages alone. Brierly* has recently published a paper on *Botrytis cinerea*. His argument is based entirely on the assumption that this species has no perfect or ascogenous stage. It is certainly unusual to state that a fungus has no ascocarpic stage simply on the basis of large numbers of cultures that produce only conidial fructifications. The recent work of Bensaude, Kniep and others, on several of the well known Basidiomycetes emphasizes the importance of growing in pairs strains or races derived from different spores, at least as a last resort, in attempts to obtain the "perfect" stages. We are finding more and more forms in which a strain, which is sterile when grown alone, still, when grown together with some other strain, at once takes part in the development of a "perfect" stage.

There is no question that *Lachnea abundans* is homothallic, a culture from a single conidium or a single ascospore being capable under suitable conditions of giving rise to ascocarps. Whatever may be the standing of the species now commonly referred to the form genus *Botrytis*, after study has revealed their ascomycetous connections, it is interesting to find an "imperfect" fungus with a botryose conidial stage connected with a little *Lachnea* which may be so easily cultured on ordinary media.

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* Mycologia **12**: 115–134. 1920.
* Phil. Trans. Roy. Soc. B. **210**: 83–114. 1920.

INDEX TO AMERICAN BOTANICAL LITERATURE
1916–1922

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to foresty, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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